# CEMENT
## & LIME MANUFACTURE

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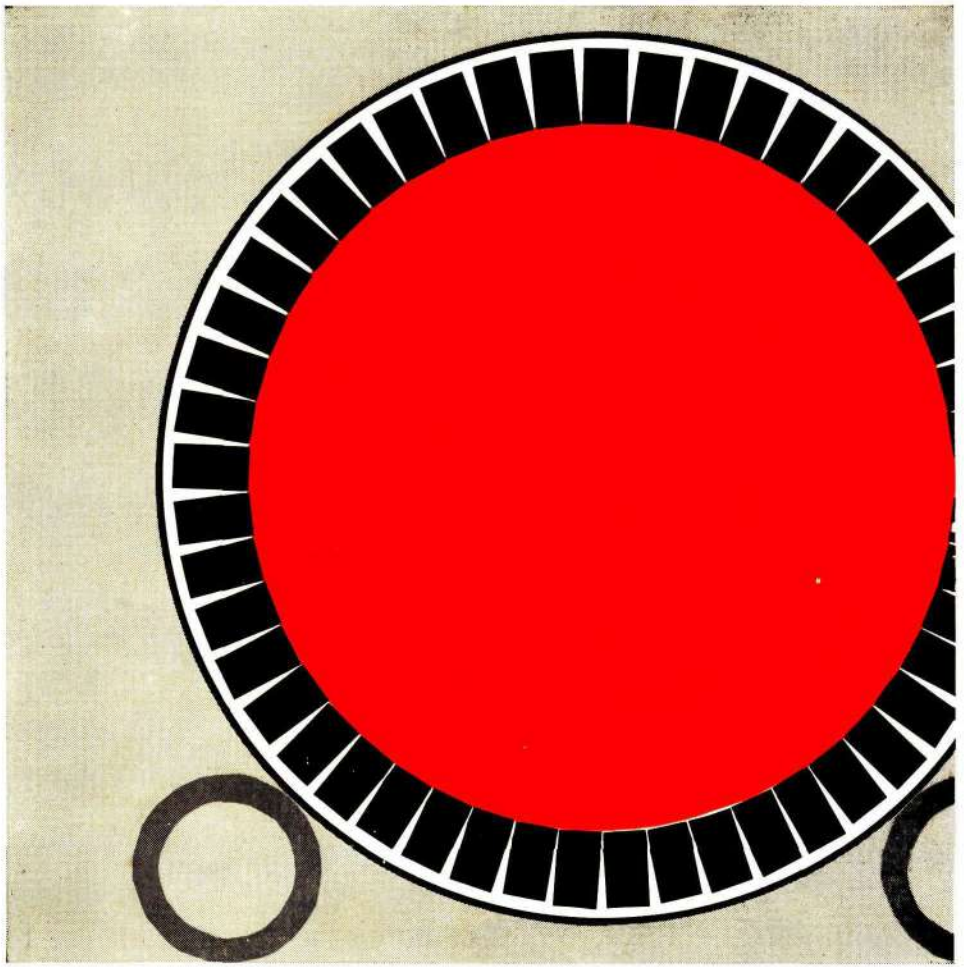


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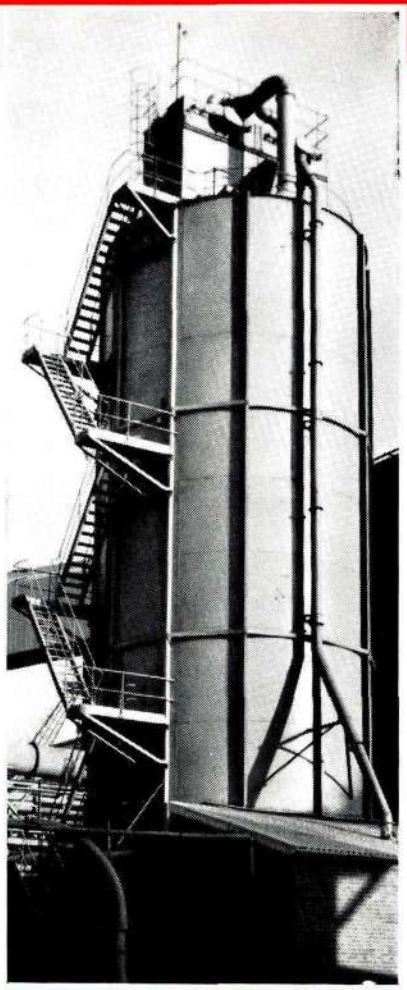

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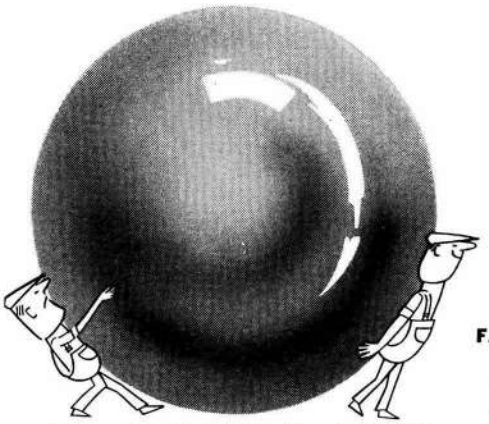

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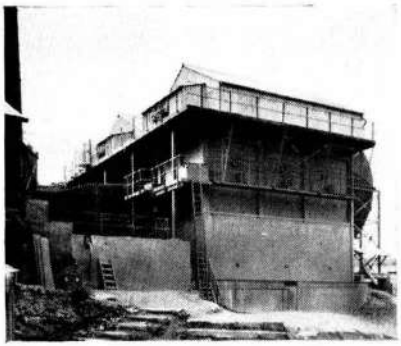

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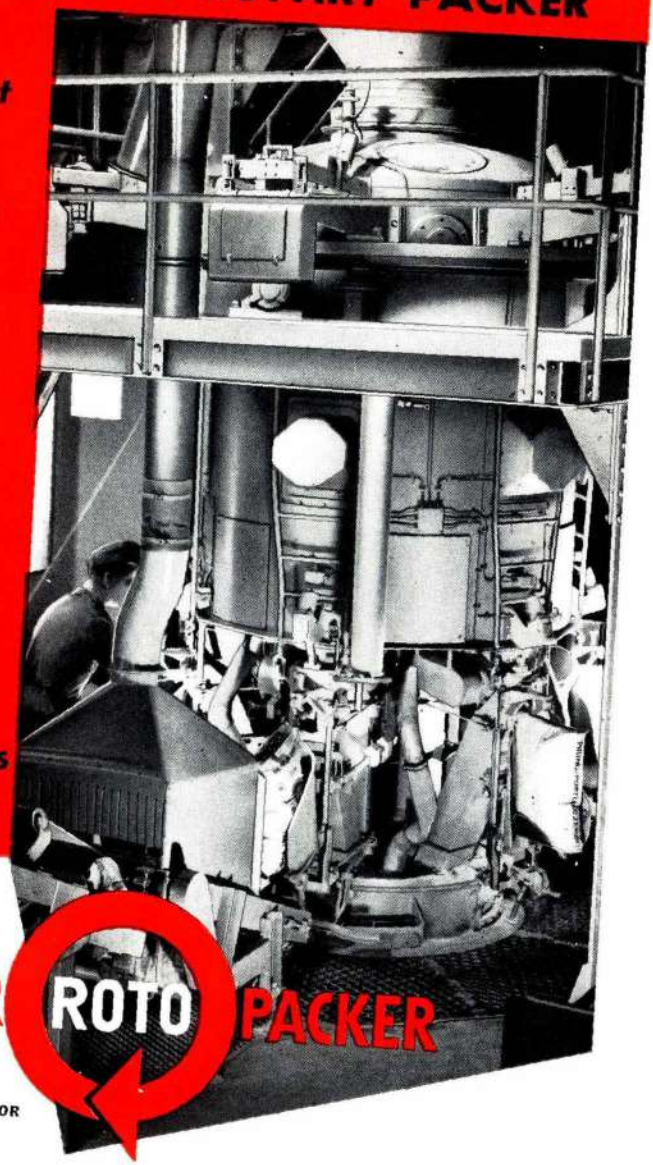

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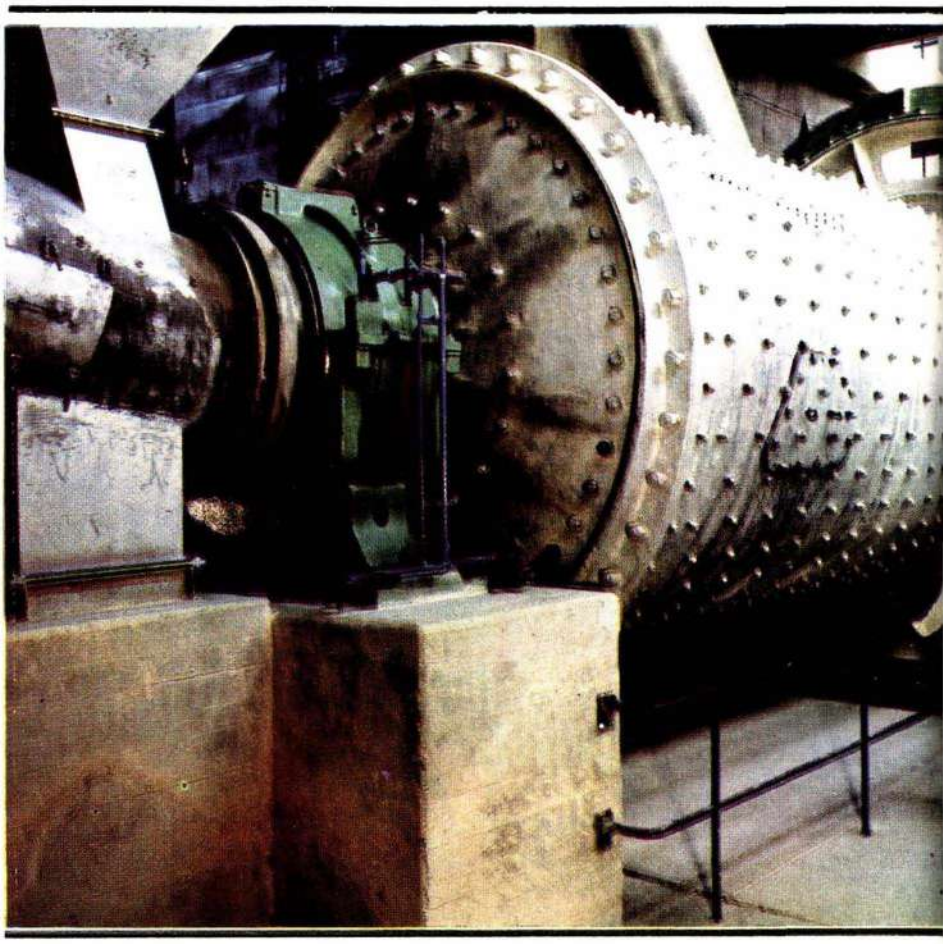

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VOLUME XXXVIII. NUMBER 3. MAY, 1965

## A Pioneer of the Cement Industry.*

### WILLIAM ASPDIN IN THE SOUTH OF ENGLAND

CONTRIBUTED BY MAJOR A. J. FRANCIS

WILLIAM ASPDIN was born at Leeds in 1815, the second son of Joseph Aspdin, bricklayer, who gave the name " Portland " to the cement he patented in 1824. It is evident that as soon as he was of an age to do so William joined his father's firm, Messrs. Aspdin & Beverley of Wakefield, Patent Portland Cement Manufacturers. The Aspdin family had been established in Leeds for over a hundred years. So too had the family of Maude, an old Yorkshire family related to the Earls of Hawarden. Edmund Maude and his eldest son William were wealthy merchants, William Maude becoming a Leeds magistrate and Deputy Lieutenant for the West Riding.

Edmund Maude's second son was John Milthorp Maude, who went to London as a young man and married there. He became a shipping and insurance broker and was for many years Secretary to the Mexican Mining Company. Joseph Aspdin and his son William no doubt had business connections with the Maude family in Leeds and it was to them they turned after making a decision to enter the London market with Portland cement. It was then arranged that William Aspdin should come to London and that J. M. Maude should form a company for manufacturing and selling Aspdin's Portland cement in the London region. J. M. Maude himself was then aged about 65 and it was no doubt also arranged that before long he would be succeeded by his two sons, Edmund and George.

William Aspdin moved with his wife to Rotherhithe in 1843, as is confirmed by the fact that their eldest daughter, Caroline, was born at Rotherhithe in this year. In the same year, J. M. Maude, Son & Co., issued a circular announcing the

* This article is another in the series based on Major Francis's research into the activities of the pioneers of the cement industry in the United Kingdom. Previous articles were published in this journal for March and November 1964.

commencement of trading, "having made arrangements with the son of the patentee for the purpose of carrying on the manufacture of this valuable cement." They emphasised that the cement was of similar colour to Portland stone, an important point at that period since Roman cement, which was then in general use, was of a dark brown colour and needed painting when applied as a stucco to buildings. It is of interest to quote the final paragraph of the circular on the subject of prices: " It is manufactured of two qualities and sold in casks of five bushels each weighing about 4½ cwts. (Note: 1 bushel = 2,218 cu. ins.); No. 1 at 3*s.* per bushel and 20*s.* per cask and No. 2 at 2*s.* 3*d.* per bushel and 16*s.* 3*d.* per cask. 4*s.* 6*d.* each allowed on the casks if returned in good condition."

In October 1843, Messrs. Grissell & Peto, the well-known building contractors in London, carried out tests of Maude's Portland cement in comparison with Roman cement at their premises near the Houses of Parliament. These were of the simple brick-beam type of specimens popular at this period, but are of importance since they are the earliest known official tests of Portland cement. The price of Roman cement was then 1*s.* 4*d.* per bushel and after the tests it was concluded that Portland cement with three parts of sand had more than double the strength of Roman cement with one part of sand and that, with Portland cement at 2*s.* 3*d.* a bushel, there was a saving in costs of 1½*d.* to 2*d.* per bushel owing to the increased sand carried by the Portland cement.

Some two years later it became possible for the Company to rent land at Northfleet, to where the works was subsequently moved. Some or all of this land may well have been previously in the occupation of Messrs. Parker & Wyatt, the introducers of Roman cement some fifty years earlier.† The Company was then re-organised under the name of Maude, Jones & Aspdin, the directors being Edmund Maude, George Maude, William Henry Jones and William Aspdin. J. M. Maude retired and it is probable that he then went abroad and died there.

However, the partnership of Maude, Jones & Aspdin only lasted a bare twelve months and on January 1, 1848, it was announced that their works had been purchased by Mr. Robins and Mr. Aspdin trading as Robins, Aspdin & Co. Why the Maude family relinquished their interest in cement so suddenly is not known. Little has been known up to the present about Mr. Robins. He was in fact a London solicitor and had already reached the age of 66 when meeting Aspdin. He had also been practising in London for some 45 years and he was now apparently prepared to give up his professon at such a late age in order to manufacture cement. This seems all the more surprising when it is known that he had no descendants to whom to hand on the business. His only son, Tugwell, had been destined for a legal career like his father and had shown great promise; but he died at the age of twenty-six.

During 1848, Messrs. J. B. White & Sons of Millbank, London, which firm had discovered the secret of making Portland cement some three years earlier, published in the technical press the results of some public experiments with their

† See this journal for November, 1964.

**Fig. 1.—An Early Concrete House: Aspdin's Home in Kent.**

material. Aspdin took immediate umbrage at this and forthwith issued a statement disputing their right to use the name Portland. He also claimed that his father introduced Portland cement in 1813 although he did not patent it until 1824 and announced that a further series of public tests of his material would be held at his firm's offices at Great Scotland Yard, London, in September of 1848. A original description of these tests with illustrations is reproduced in *Fig.* 2 on pages 46 and 47.

At the Great Exhibition held in London in 1851, Messrs. Robins, Aspdin & Co., exhibited their cement in common with other leading manufacturers. The report of the Exhibition mentions that they exhibited " a gigantic slab of Portland cement measuring 20 ft. by 12 ft. by 10 ins. thick and weighing 15 tons; numerous blocks of cement and concrete proved to various pressures up to 154 tons; of bricks cemented together so as to give a pressure of 3 tons on the first brick and several other illustrations." They were awarded a Prize Medal.

In spite of the success of the Exhibition, the partnership of Robins and Aspdin was evidently not flourishing because in November of the same year came the announcement that the partnership had been dissolved on November 7 by judicial decree. At the same time it had apparently been necessary to obtain an injunction restraining Aspdin from removing or interfering with the assets of the partnership.

So ended in failure eight years of cement production in the South of England, by William Aspdin. The reasons for his failure are not yet clear, but a correspondent writing to " The Builder " in 1880, although obviously very inaccurate, throws some light on the matter. An extract from his letter reads: " In the recent papers on Portland cement in your journal there is no mention of Mr. William Aspdin, the inventor. His career being a sad one, it may not be inopportune to state what little we know. His confidence in his invention was great—so great that it caused his ruin. Before the material had become properly understood, he launched out by renting several acres of land near Gravesend and commenced building Portland Hall in such an elaborate and artistic manner as to require some £40,000

## EXPERIMENTS ON CEMENT.

A good deal of attention has recently been directed to the merits of a cement called "Portland" cement, manufactured by Messrs. Aspden and Robins, of Northfleet; and on Monday, the 18th ult., a numerous body of architects, builders, &c., assembled at the town premises of these gentlemen, in Great Scotland-yard, to witness a number of experiments with the cement, both alone and in combination with sand, in different proportions; the following are some of the trials made:—

*Best Stock Bricks Cemented against the Wall.*

*Experiment* 1.—17 stock bricks were cemented together with *roman cement* (all cement) and projected before the face of a wall, as fig. 1. They broke down with 7 lb. placed on the end.

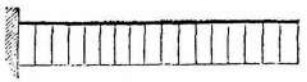

Fig. 1.

*Experiment* 2.—11 stock bricks, cemented together wi[illegible]nd and 1 roman cement, broke down with 7 lb. placed on the end.

*Experiment* 3.—38 bricks, cemented with neat, patent *portland cement*, broke down with 14 lb. placed on the end.

*Experiment* 4.—30 bricks, cemented together with 1 portland cement and 1 sand, broke down with 15 lb. at end.

*Experiment* 5.—22 bricks cemented together with 1 portland cement and 2 sand, broke down with 168 lb. at end.

*Experiment* 6.—25 bricks, with 1 portland cement and 4 sand, broke down with 56 lb. at end.

*Experiment* 7.—26 bricks, with 1 portland cement and 5 sand, broke down with 7 lb. at end.

*Experiment* 8.—14 bricks, all portland cement, with a wheel of 9 cwt. in the centre, broke down with 17 lb. at end.

*Experiment* 9.—16 bricks, cemented together with 1 portland cement and 1 sand, and suspended at both ends, broke down with 15 cwt. placed in a scale suspended on the centre. (*See* fig. 2).

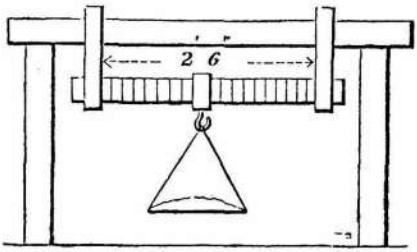


Fig. 2.

*Experiment* 10.—A block of portland stone, 2 ft. 11 in. long, and 9 by 9 inches, broke with a weight of 38 cwt. (*See* fig. 3.)

*Note.*—A block, cemented with roman cement, would not bear the weight of the stone, in a similar position.

Fig. 2. Part 1.

(*Continued on facing page.*)

**Fig. 2: Part II.**

*(Continued from facing page.)*

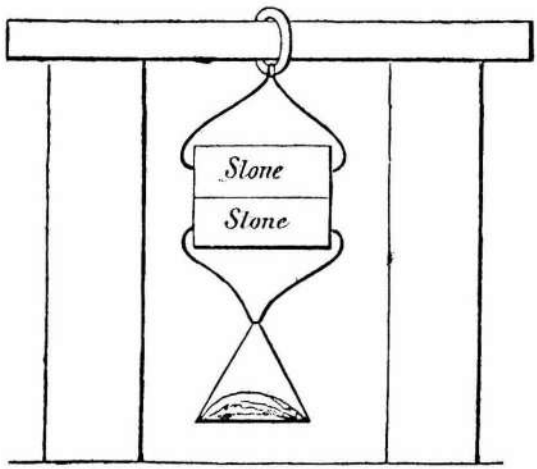


Fig. 2.

*Trials in a Hydraulic Press.*

*Experiment* 11.—A block, all portland cement, 18 inches high and 9 × 9 inches, bore a pressure equal to 108½ tons on the square foot.

*Expt.* 12.—A mixture, 1 sand and 1 cement, ... 80 tons sq. foot.

*Expt.* 13.—A mixture, 4 „ 1 „ ... 80 „ „

*Expt.* 14.—A mixture, 7 „ 1 „ ... 44½ „ „

*Experiment* 15.—A block, all roman cement, broke at 22½ tons.

*Experiment* 16.—A mixture, 4 parts sand and 1 roman cement, would not bear any pressure.

*Experiment* 17.—A block of portland stone, 1½ in. × 1 in., broke up at 23 cwt.

*Experiment* 18.—A block of the portland cement, the same dimensions, broke with 18 tons.

to bring it to completion. When the structure was rather more than a third up he had to stop, and he sold off at so great a sacrifice that he left the country and died abroad."

As is well-known, Aspdin on leaving Northfleet went to Gateshead-on-Tyne where he began yet another partnership, trading as Aspdin, Ord & Co. This final venture began in late 1852 but failed in 1856. William Aspdin then migrated to Germany and afterwards died there. During much of his time in Kent, Aspdin lived at Grove House, Northfleet. This house though derelict is still standing and an illustration is given in *Fig.* 1. To the right, but not seen in the illustration, is the Bevan's Works of The Associated Portland Cement Manufacturers Ltd., the site being previously occupied by the early cement firm of Knight, Bevan & Sturge, which was established in Northfleet a few years after the arrival of Robins and Aspdin.

Although over 70, Mr. Robins continued trading on his own as Robins & Co., and several years later he is mentioned in the Proceedings of the Institution of

Civil Engineers wherein are reported the results of tests of Portland cement carried out by Mr. John Grant, engineer to the Metropolitan Board of Works. Iu 1865, on reaching the age of 83, Robins decided to convert his business into a limited company. Robins & Co. Ltd., was formed with a share capital of £100,000, the greater part being subscribed by a Mr. Robert Hume, a " carver and gilder " of 65 Berners St., London, whose nephew, R. A. Gibbons, was Mr. Robins's works-manager. Robins continued as a director but died in 1868. His company continued in being until 1900, when it was taken over by The Associated Portland Cement Manufacturers Ltd. The land on which their works stood is still known as Robins Wharf. It now belongs to Shell-Mex & BP Ltd., and is used as a petrol installation.

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## Conferences.

### Sixth Silicate Industry Conference.

THE Proceedings* of the Conference on the Silicate Industry, which was held in Budapest in October 1961, have now been published. The contents include papers on, among other subjects, the effect of air humidity on lime-burning; the effect of grinding on the structure of crystalline substances investigated by differential thermal analysis, refractories and non-destructive testing, the process and equilibrium phase of grinding, contributions to the theory of cement setting, the chromium content of cement, determination of conditions in the sintering zone of rotary kilns, potash balance of cement shaft-kilns with regard to potash recovery, and the utilisation of the flue dust from rotary kilns.

### Eighth Conference on the Silicate Industry.

The Eighth Conference on the Silicate Industry, which is organised jointly by the Scientific Society of the Silicate Industry and the Veszprem University, will be held from June 9 to 12, 1965, in Budapest. Particulars can be obtained from SILICONF, House of Engineering, Budapest, V., Szabadság tér 17.

Subjects of interest to the cement industry which are to be discussed include the structure of hydrated Portland cement paste and concrete, transportation of material and homogenisation and modern kilns. The official languages at the Conference are Hungarian, English, Russian and German.

### Cement Industry Conference.

THE 1965 Technical Conference organised by the Cement Industry Committee of the Institute of Electrical & Electronic Engineers Inc., was held at the George Washington Motor Lodge, Allentown, Pennsylvania, U.S.A., on May 11 and 12, 1965.

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* "Proceedings of the sixth conference on the silicate industry. (Budapest, October, 1961.)" Budapest Publishing House of the Hungarian Academy of Sciences. 1963. In English. 469 pages. Price 12 dollars.)

# Anhydrite Cement in Hot Climates.

BY M. TENNY AND M. BEN-YAIR*

ANHYDRITE gypsum ($CaSO_4$) is an anhydrous mineral by nature and no calcination is needed for its industrial application. If the anhydrite is ground to a fine powder together with a catalyser and then water added, it will bind two molecules of water and form gypsum dihydrate ($CaSO_4.2H_2O$). The gypsum hardens physically while binding the water, and this explains why anhydrite has the binding qualities of a cement. Anhydrite cement has been used successfully to replace Portland cement in Asiatic Russia, and Germany. Its main advantage is that its production is much cheaper than the production of Portland cement since it does not need high temperatures for its production nor expensive mechanical grinding of the hard clinker. The mechanical strength of anhydrite-cement mortars is sufficient for the production of building blocks for walls where high strengths are not required.

The water binding in anhydrite decreases with the rise of temperature. At temperatures above 42 deg. C., no water binding takes place. This phenomenon, which is no obstacle to its use in cold climates, could prevent its use in the hot and dry climates such as that of the Negev region in Israel where anhydrite is found. The chemical composition of anhydrites obtained from this region are given in *Table* I. The mineralogical composition of anhydrite gypsum is 92·8 per cent. of $CaSO_4$ and that of gypsum dihydrite is 3·8 per cent. of $CaSO_4.2H_2O$.

The influence of the rise of temperature on the strength development of building elements made from anhydrite cement has been investigated in the laboratory of the Standards Institution of Israel. The temperature beyond which it is no longer technically practical to produce the anhydrite-cement mortars was determined. It was found that, after the anhydrite cement had bound water and set, high temperatures do not diminish its strength. On the basis of the results obtained, a method was developed for the production of building elements from anhydrite cement in hot climates. The method is based on the principle of producing and curing the mortar at maximum humidity.

## Investigation of Various Catalysers at Different Temperatures.

There is a basic difference between gypsum hemi-hydrate and anhydrite gypsum. The former binds rapidly with water to form gypsum dihydrate at all

TABLE I.—CHEMICAL COMPOSITION OF ANHYDRITE FROM THE NEGEV, ISRAEL

| | | Per cent. |
|---|---|---|
| Free water (dried at 50°C) | $H_2O$ | 0·4 |
| Combined water (dried at 230°C) | $H_2O$ | 0·8 |
| | $SO_3$ | 56·3 |
| | CaO | 39·6 |
| | MgO | 1·0 |
| | $R_2O_3$ | 0·4 |
| | $SiO_2$ | 0·5 |
| | Cl | 0·5 |
| | $CO_2$ | 0·3 |

*The authors are attached to the Standards Institution of Israel.

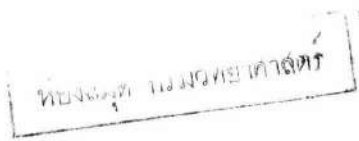


TABLE II.—STUDY OF INFLUENCE OF CATALYSERS ON STRENGTH OF ANHYDRITE CEMENT MORTARS UNDER DIFFERENT TEMPERATURES AND IDEAL HUMIDITY CONDITIONS

| Temperature deg. C | Catalyser | Compressive strength kg. per sq. cm. | | Combined water percentage of anhydrite | |
|---|---|---|---|---|---|
| | | 7 days | 28 days | 7 days | 28 days |
| 15 | Potassium sulphate | 21 | 71 | 8·0 | 15·6 |
| | Potassium sulphate + zinc sulphate | 62 | 105 | 14·4 | 18·0 |
| 24 | Potassium sulphate | 10 | 20 | 3·2 | 13·6 |
| | Potassium sulphate + zinc sulphate | 45 | 51 | 9·6 | 16·0 |
| 35 | Potassium sulphate | 9 | 10 | 2·4 | 4·0 |
| | Potassium sulphate + zinc sulphate | 20 | 40 | 4·8 | 8·4 |
| 45 | Potassium sulphate | 4 | 6 | 1·2 | 1·6 |
| | Potassium sulphate + zinc sulphate | 6 | 6 | 2·8 | 3·6 |

TABLE III.—DEVELOPMENT OF STRENGTH OF MORTAR WITH TIME

| SAMPLE | CUBES | | | | PRISMS | | | | | | | | BRIQUETTES | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Strengths kg. per sq. cm. | Compressive strength | | | | Compressive strength on prisms after bending test | | | | Bending strength | | | | Tensile strength | | | |
| Catalyser | Ammonium sulphate | | Mixed sulphates | | Ammonium sulphate | | Mixed sulphates | | Ammonium sulphate | | Mixed sulphates | | Ammonium sulphate | | Mixed sulphates | |
| Place of storage | Lab. | Eilat | Lab. | Eilat | Lab. | Eilat | Lab. | Eilat | Lab. | Eilat | Lab. | Eilat | Lab. | Eilat | Lab. | Eilat |
| 7 days .. .. | 7·5 | — | 17 | — | 14 | — | 21 | — | 5 | — | 6 | — | 4·5 | — | 8 | — |
| 28 days .. .. | 12 | 16 | 31 | 40 | 21 | 29 | 33 | 58 | 7 | 7 | 14 | 18 | 7 | 8 | 15 | 15 |
| 90 days .. .. | 16 | 12 | 52 | 52 | 26 | 24 | 54 | 47 | 9 | — | 19·5 | — | 5 | — | 13 | 9 |
| 360 days .. .. | 20 | x | 54 | 71 | 20 | x | 43 | 71 | 7 | x | 17 | 20 | 3 | x | 10 | 10 |

x=Samples disintegrated while stored at Eilat.

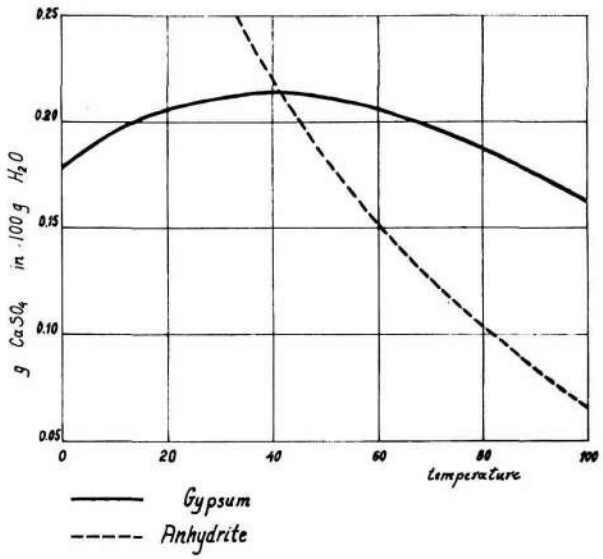



**Fig. 1.—Solubility Curves of Anhydrite and Gypsum.**

normal temperatures (for example in the range of 1 deg. to 50 deg. C.). This means that hot dry climatic conditions do not impair the binding of gypsum hemi-hydrate. The rapidity of binding of the anhydrite, on the other hand, is limited and decreases with increase in temperature.

Theoretical calculations indicate that at temperatures above 42 deg. C., water does not bind at all with anhydrite. The reason for this is apparent from the solubility curves of gypsum dihydrate and anhydrite. Up to the limiting temperature, the solubility of anhydrite is higher than that of gypsum, but above this temperature the solubility of gypsum is higher. Therefore at temperatures above the limiting temperature, all the dissolved anhydrite will settle out again as anhydrite, and not as gypsum dihydrate (*Fig.* 1).

In connection with these technical limitations, which result in a lowering of the strength of mortar mixtures of anhydrite cement with increase in temperature, an experiment was performed to test the reduction in strength at various temperatures, in order to determine the limiting temperature above which it is impossible to produce anhydrite-cement mixtures of satisfactory strength. This experiment is of practical importance in regions where the temperature remains between say 30 and 40 deg. C. during the summer.

It was determined from previous work(1), that at optimum conditions of maximum relative humidity and a suitable temperature of 15 deg. C, there are noticeable differences in the action of various catalysers and the strengths of

(1)M. Tenny and M. Ben-Yair: " Technological Studies on Anhydrite Cement from the Negev ", 1962. (In Hebrew).

mortars obtained as a result of their use. As the conditions become more severe, the importance of the catalysers increases.

For this test, two of the best catalysers known from experience were chosen, namely potassium sulphate, and a mixture of potassium sulphate and zinc sulphate. The tests were made at various temperatures, namely 15 deg., 24 deg., 35 deg. and 45 deg. C. Mortar mixtures were prepared in the ratio of 1 : 3 : 0·4 of anhydrite : sand : water; the mixtures were of moist consistency such as permitted immediate dismantling of the moulds, that is about 10 per cent. of water to total mixture. The specimen cubes were stored in sealed drums which contained a glass of water to provide a fixed maximum humidity.

The samples were tested for compressive strength after seven and twenty-eight days, and were dried in an oven at 50 deg. C. for two days before being tested.

The results of the tests are given in *Table* II, from which the following conclusions may be drawn.

*a.*—There is a great advantage towards achieving optimum strength in the use of mixed catalysers, as against catalysers which contain only a single sulphate.

*b.*—At 35 deg. C., a reasonable strength is obtained by the addition of a mixed catalyser. On the other hand, the strength obtained when using a single catalyser is 50 per cent. below that specified in the German Standard for anhydrite cement (D.I.N. 4208).

*c.*—At 45 deg. C., a low strength is obtained by the addition of two types of catalysers. From this it may be deduced that there is a certain temperature at which the binding of water falls off steeply, irrespective of the efficiency of the catalysers.

*d.*—Provided that cement-anhydrite products are stored for a few days after their preparation in humidified chambers (at a relative humidity of 99 per cent.), there is a chance of reaching optimum strength even at temperatures of 30 deg. to 35 deg. C.

However, it is still doubtful whether also at temperatures above 35 deg. C., adequate compressive strengths will be obtained by preliminary storage at maximum humidity.

## The Development of the Strength of Anhydrite-cement Mortar with Time under Various Climatic Conditions.

The test samples were stored for one year under various climatic conditions. The influence of two important factors on the strength of anhydrite-cement mortar was tested, the first being time, and the second climate. The effects of a temperate and humid climate and a hot dry climate were compared.

Samples were prepared for testing the specific strengths in compression and in bending. The specimens were 7-cm. cubes and 4×4×16-cm. prisms and briquettes. The mixtures were of wet consistency, but permitting immediate de-moulding, with a ratio of 1 : 3 of anhydrite : sand, and a ratio of water to anhydrite of 0·4 by weight. During the preparation of the samples, the prevailing temperature was 25 deg. C. and the relative humidity 70 to 85 per cent.

The specimens were stored for the first three days in a humidified chamber (24 deg. C., 92 per cent. relative humidity) in order to prevent the water in the mixture from evaporating during the first days of binding; afterwards they were stored for an additional eleven days in the open in the laboratory. Half of the specimens were kept at the laboratory at the Standards Institution, and the other half were sent after two weeks to a hot dry region, where they were stored outdoors on tables.

For the sake of comparison, two types of catalysers were used, namely, 1 per cent. of ammonium sulphate, and 1 per cent. of potassium sulphate mixed with 1 per cent. of zinc sulphate.

## Results

From the results of the mechanical tests performed over a period of one year (*Table* III), it appears that combining of the suitable processing method and the selection of the best catalyser (in this case the mixed sulphates), produced an anhydrite-cement mortar of strength exceeding that required in the German Standard (D.I.N. 4208) and resistant to the climatic conditions of the Negev. However, the mixture to which ammonium sulphate was added did not develop the minimum strength required by the German Standard, and in time the specimens which were stored in the hot dry climate began partly to disintegrate and for this reason could not be tested.

It appears that the compressive strength of the specimens increased mainly up to ninety days. The bending strength increased up to ninety days, after which it remained constant or decreased slightly. The tensile strength increased up to twenty-eight days, and then decreased.

It became clear that, if during the curing period the cement binds with the optimum amount of water required for its acquiring maximum strength, then a subsequent higher temperature or lower humidity does not have any adverse effect. Good catalysers are of basic importance for achieving maximum strengths, and it is therefore desirable to continue the search for better catalysers which will enable optimum mechanical strengths to be attained at temperatures higher than those prevailing in the Mediterranean area or in Europe.

---

## Cement Production in the United Kingdom.

ACCORDING to statistics issued by the Ministry of Public Building and Works, the total production of cement in the United Kingdom for the year 1964 was 16,698,000 tons, which constitutes a record for the industry. The corresponding amount for 1963 was 13,837,000 tons. Deliveries within the country amounted to 13,612,000 tons in 1963 and 16,544,000 tons in 1964.

---

# Thermal Insulation at Cement Works.

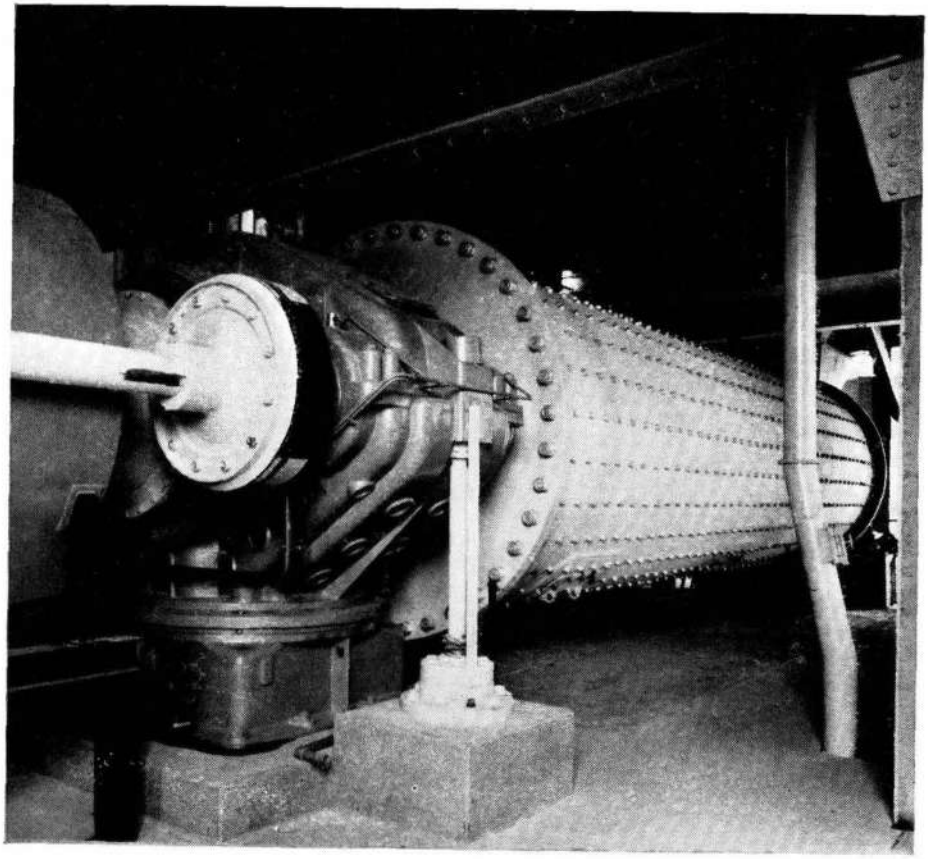
THE current expansion programme of Eastwood Cement Co.'s works at Barrington, Cambridgeshire, has increased the productive capacity by two-thirds. A new rotary kiln 440 ft. long and ancillary plant have been installed. Attention has been paid to the thermal insulation of the plant both as regards the effects of frost and the prevention of condensation. Freezing of the slurry would result in a stoppage in the supply and overflow pipes, while condensation inside the dust collectors, ducting and coal hoppers can cause corrosion and would also prevent the free flow of materials.

The supply and overflow pipes (*Fig.* 1) from the slurry tank to the kiln are insulated with a 2-in. layer of proprietary insulating material, which is covered with two-ply roofing felt, secured by 1-in. wire netting and painted with two coats of bitumen for protection from the weather.

Insulation provided on the kiln smoke chamber to prevent the temperature falling below dew-point and causing condensation, comprises 2-in. and 3-in. slabs of another proprietary insulating material which is covered with 20-g. aluminium sheeting. Similar insulation is provided on the dust collector and ancillary ducts. Where the ducts are outside the building, the slabs are covered with 1-in. wire netting, a $\frac{1}{2}$-in. layer of a hard-setting composition and a $\frac{1}{4}$-in. layer of waterproofing material (*Fig.* 2). The hopper for the pulverised coal, with which the kiln is fired, is insulated against condensation with a 3-in. layer of insulating material retained with wire netting covered with 20-g. aluminium sheeting. The dust collector and ancillary ducting, in the cement mill building (*Fig.* 3) are

**Fig. 1.**

# LARGE CEMENT AND RAW MILLS



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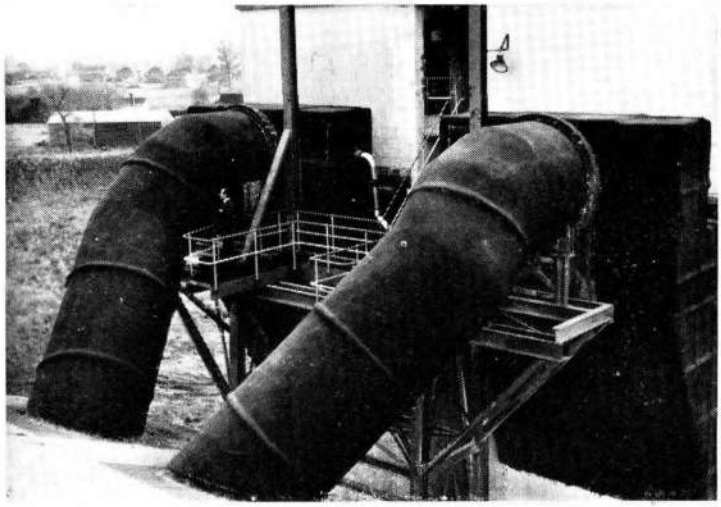


Fig. 2.

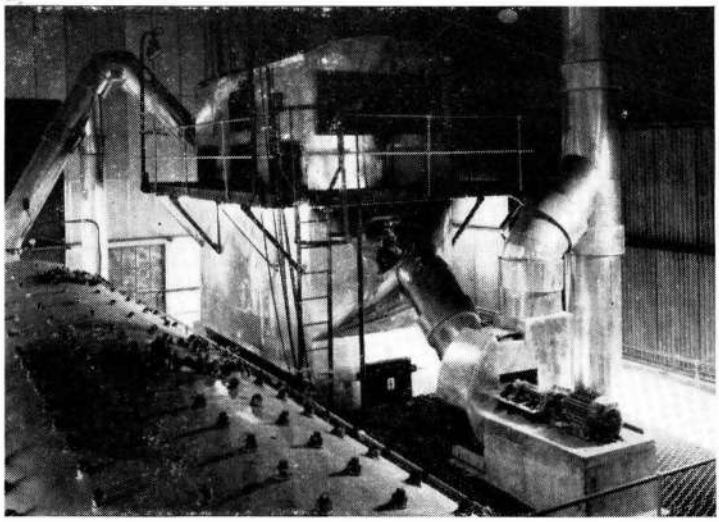


Fig. 3.

insulated against condensation with 2-in. and 4-in. layers of material covered with 20-g. aluminium.

The insulating materials were supplied by Stillite Products Ltd., the application including the cladding being carried out by I.M.C. (Thermal Insulations) Ltd. The main contractors for the Barrington development were Messrs. John Laing & Sons Ltd.

## Gehlenite Hydrate in Portland Cement.

A STUDY conducted recently at the Building Research Division of the U.S.A. National Bureau of Standards Institute of Applied Technology and involving the hydrothermal treatment of cement, has, it is reported*, led to the discovery of a hitherto unreported crystalline compound. The form of the crystals is shown in *Fig.* 1.

The new compound is a gehlenite hydrate having the formula $2CaO.Al_2O_3.SiO_2.H_2O$. Inasmuch as the hydrate was formed only at temperatures higher than 250 deg.C., the compound would not be expected to be found in steam-cured concrete. From the X-ray diffraction pattern, it was deduced that the compound has a body-centred cubic structure, with unit cell edge of 8.83 Å. The index refraction is 1·628. The formula indicates a relationship to the mineral gehlenite, $2CaO.Al_2O_3.SiO_2$, a fact which is of interest because gehlenite reacts with water,

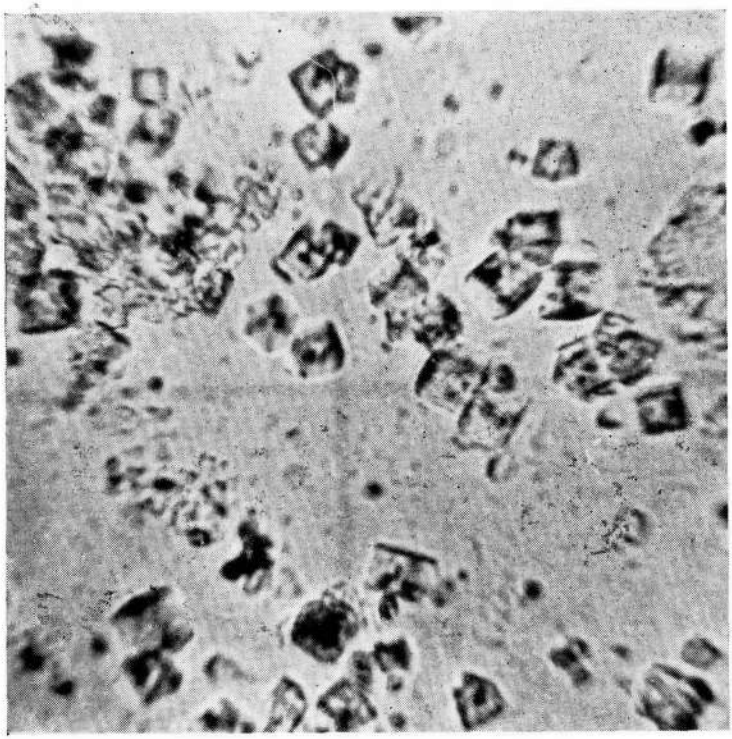
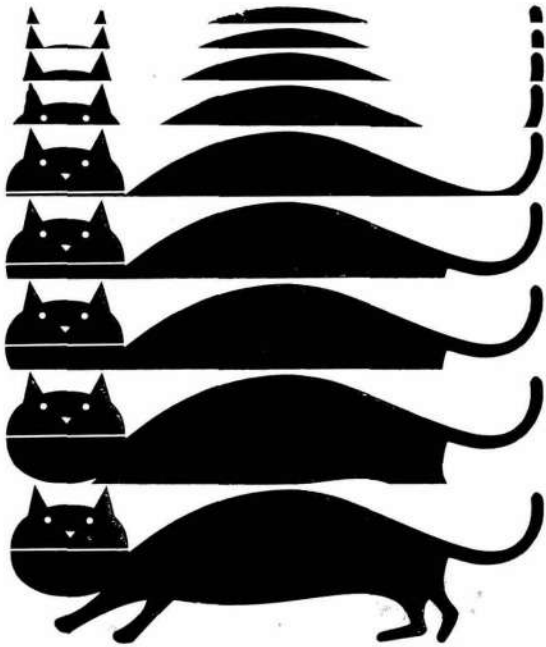


**Fig. 1.—Crystals of Gehlenite Hydrate.**
(*Width of illustration: 10 microns*)

* "Hydrothermal Preparation of a Gehlenite Hydrate". By Elmer T. Carlson, J. Research, N.B.S. 68A (Phys. and Chem.) No. 5, (Sept. Oct. 1964).



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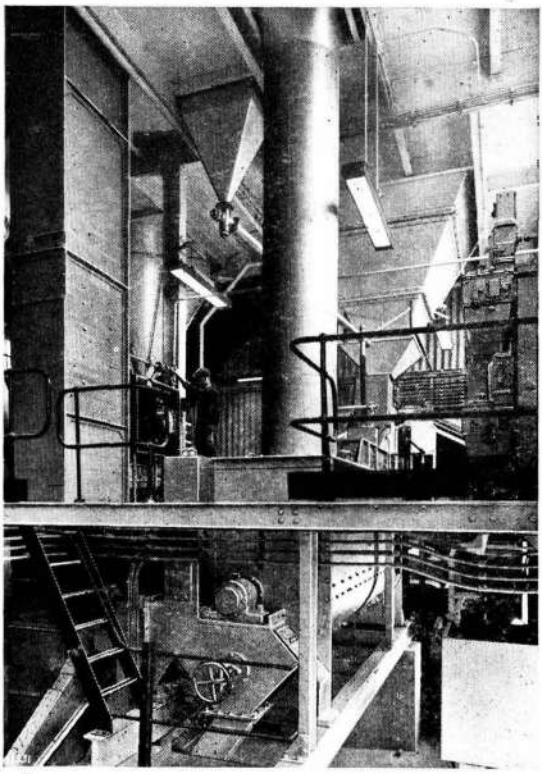

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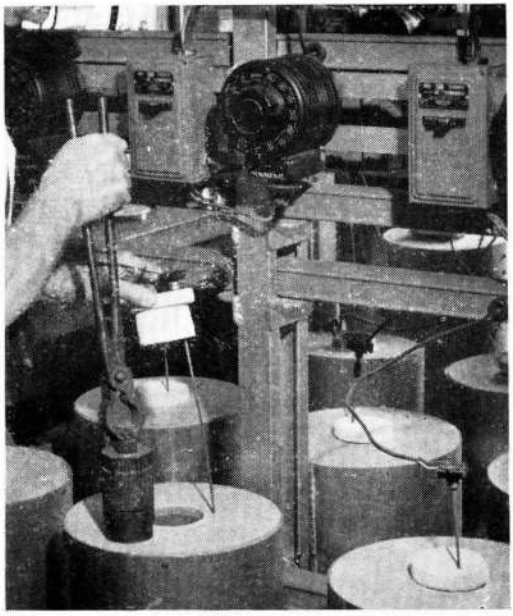

**Fig. 2. Furnaces for Hydrothermal Treatment.**

under hydrothermal conditions, to form a hydrogarnet, in which the ratio of CaO to $Al_2O_3$ is 3 : 1 rather than 2 : 1. At room temperature, gehlenite is practically inert towards water, but a compound of composition $2CaO.Al_2O_3.SiO_2.8H_2O$ (often called gehlenite hydrate) can be prepared by hydration of glasses of gehlenite composition as well as by other means.

In the investigation concerned, a preparation of synthetic gehlenite was converted hydrothermally to the new hydrate at 260 to 650 deg.C., but at a lower temperature (182 deg.C.) hydrogarnet was formed. Similar results were obtained with a specimen of natural gehlenite, but with minor differences attributed to impurities, such as MgO and $Fe_2O_3$, in the natural mineral. The new gehlenite hydrate, $2CaO.Al_2O_3.SiO_2.8H_2O$, reacted hydrothermally in a similar manner, forming the monohydrate at the higher temperatures, but in the intermediate range converting to a hydrogarnet. The furnaces used for the hydrothermal treatment are illustrated in *Fig.* 2. The compositions of compounds and mixtures subjected to hydrothermal treatment are shown in *Fig.* 3 in relation to the anhydrous system $CaO.Al_2O_3.SiO_2$.

It is concluded, therefore, that on hydrothermal heating, $2CaO.Al_2O_3.SiO_2.8H_2O$ is first converted to a hydrogarnet, with the release of a part of the $Al_2O_3$ and $SiO_2$. Then, as the temperature is raised above 260 deg.C, the hydrogarnet is broken down and the oxides recombine as $2CaO.Al_2O_3.SiO_2.H_2O$. A similar sequence of reactions presumably occurs when gehlenite or the mixed oxides are used as starting materials. Complete conversion was never attained, as even the

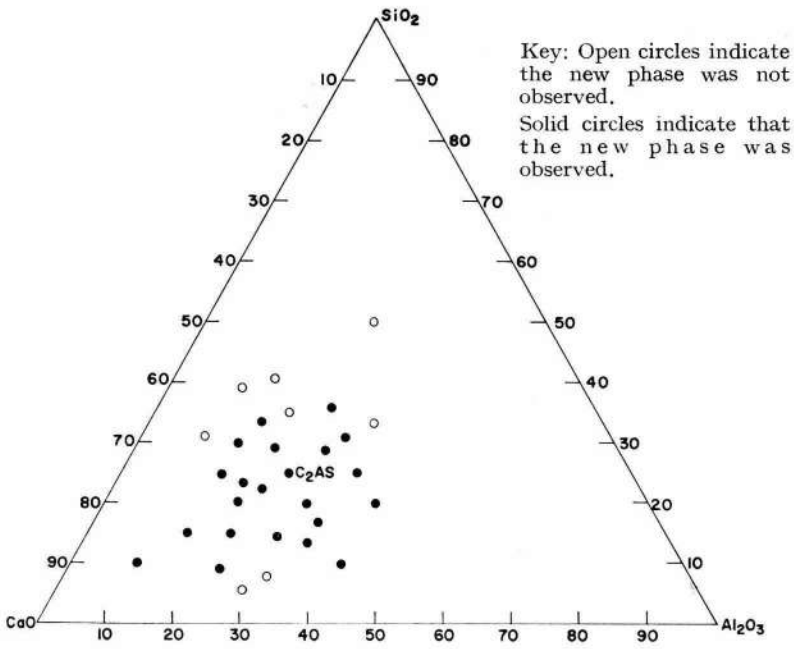


**Fig. 3. Compositions of Compounds and Mixtures subjected to Hydrothermal Treatment shown in relation to the anhydrous system $CaO.Al_2O_3.SiO_2$**

best preparation of the new hydrate contained a small amount (perhaps 5 per cent) of hydrogarnet.

The new compound may be called a gehlenite hydrate on the basis of its stoichiometry, despite the indications that the gehlenite does not hydrate directly but goes through the hydrogarnet stage.

---

## Cement Industry in the Middle East.

**Pakistan.**—Large consignments of cement are being exported from Russian ports in the Far East to Pakistan. Shipments in September last amounted to more than 10,000 tons. The total amount of Soviet cement imported into Pakistan in 1963 was 77,000 tons. Soviet cement was also being exported last year to nineteen countries including Malta and 5,500 tons to Guinea.

**India.**—A complete cement-making plant is being supplied by Poland to India. The plant will be installed in a works near the Bhilai steel works and is expected to be in operation in 1966.

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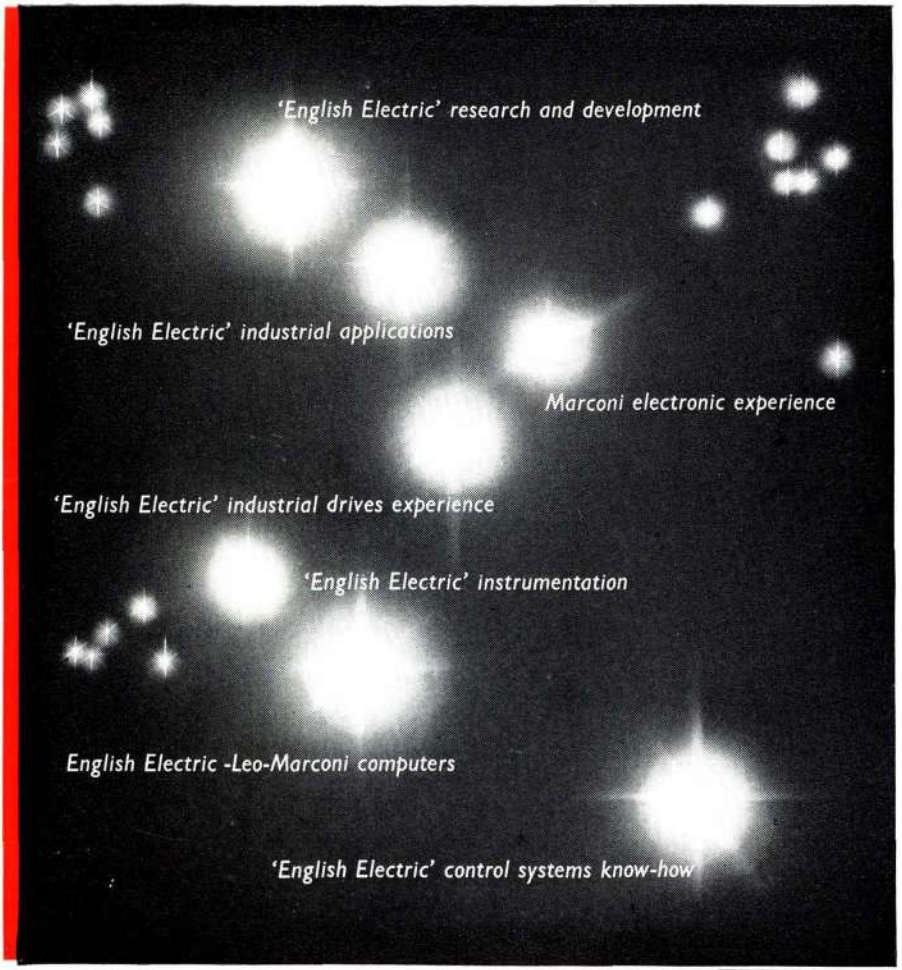
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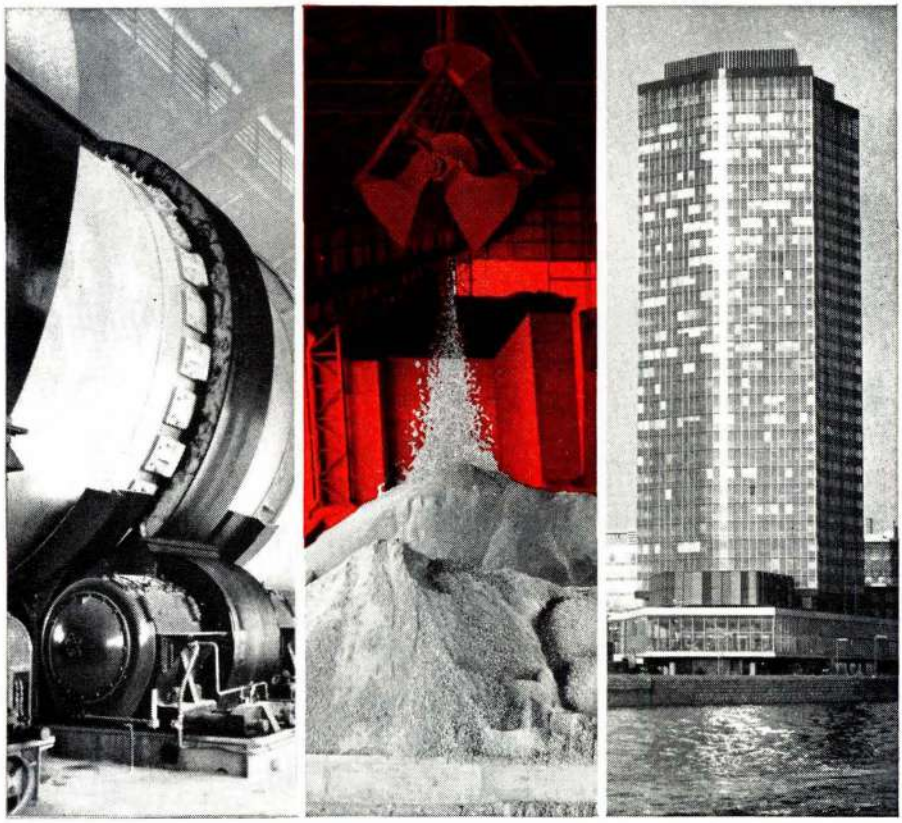

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## New Plant for Raw Material

LIMESTONE CRUSHING PLANT.—The machine illustrated in *Fig.* 1 is a 23-ft. diameter "Aerofall" mill being erected at the works of the manufacturers, Messrs. Ashmore, Benson, Pease & Co., Ltd. The mill will be used for the crushing and grinding of limestone for the new Weardale cement works of The Associated Portland Cement Manufacturers Ltd. A similar machine is to be supplied to a cement works in Norway.

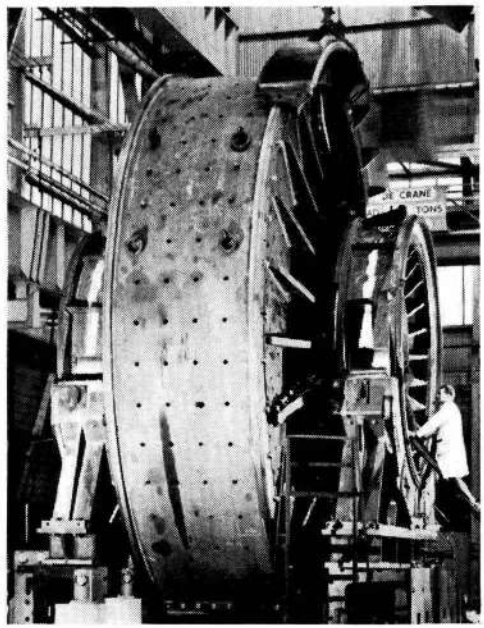


**Fig. 1. Mill for Crushing Limestone at Weardale Works.**

A CHALK CRUSHER.—The Pennsylvania Dixie non-clog hammermill illustrated in *Fig.* 2 was supplied by G.E.C. (Engineering) Ltd., and installed recently in the Melton Bottoms quarry of Messrs. G. & T. Earle Ltd., at North Ferriby, Yorkshire. The machine is required to crush lumps of chalk, having a maximum size of 12-in. cube, down to 2-in. at a rate of 200 tons per hour. This is a particularly heavy duty because the material may have a high moisture content and contain pieces of flint. To enable wet and sticky material to be crushed, the machine is fitted with a moving breaker-plate which pulls the material down into the crushing zone. The chalk is obtained from the overburden of the deposit of clay which is excavated for use in the cement works. The chalk thus removed is dumped by a mechanical shovel into a hopper fitted with a 12-in. screen and discharging into an elevator which lifts the material to a height of about 25 ft. to the hammermill. The hammermill is constructed on the same principle as a conventional swing hammermill except that it is fitted with a moving breaker plate to pull the wet and sticky chalk down into the crushing

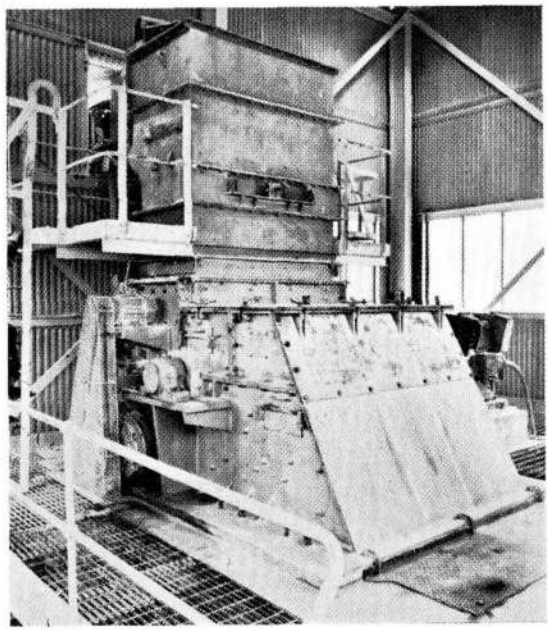

**Fig. 2. Chalk Crusher at Melton Bottoms Quarry.**

zone. After passing through the hammermill, the chalk is transported by another conveyor to the main part of the works for further treatment.

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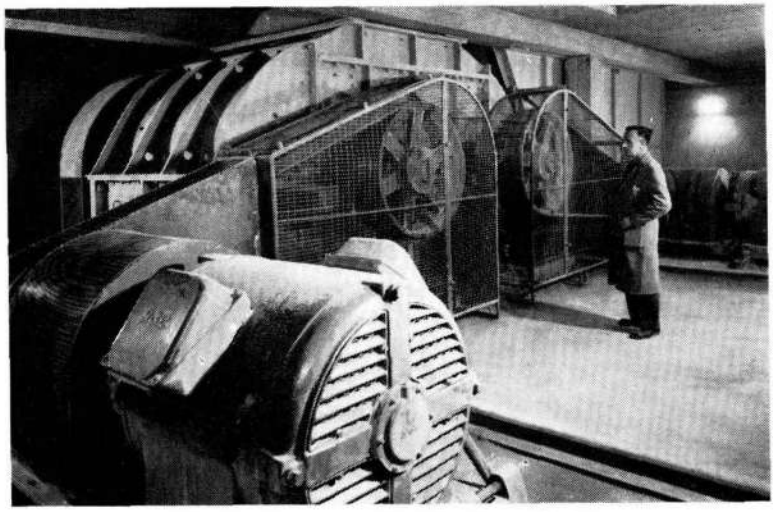

**Fig. 3.—Hammermill at Southam Works.**

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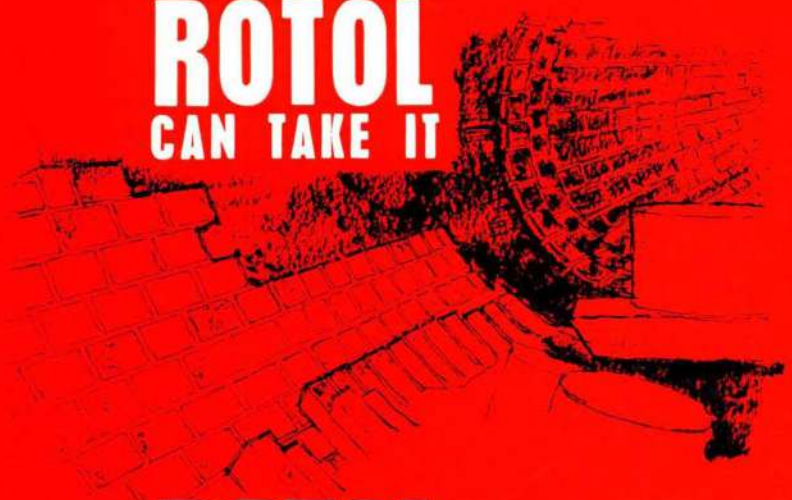

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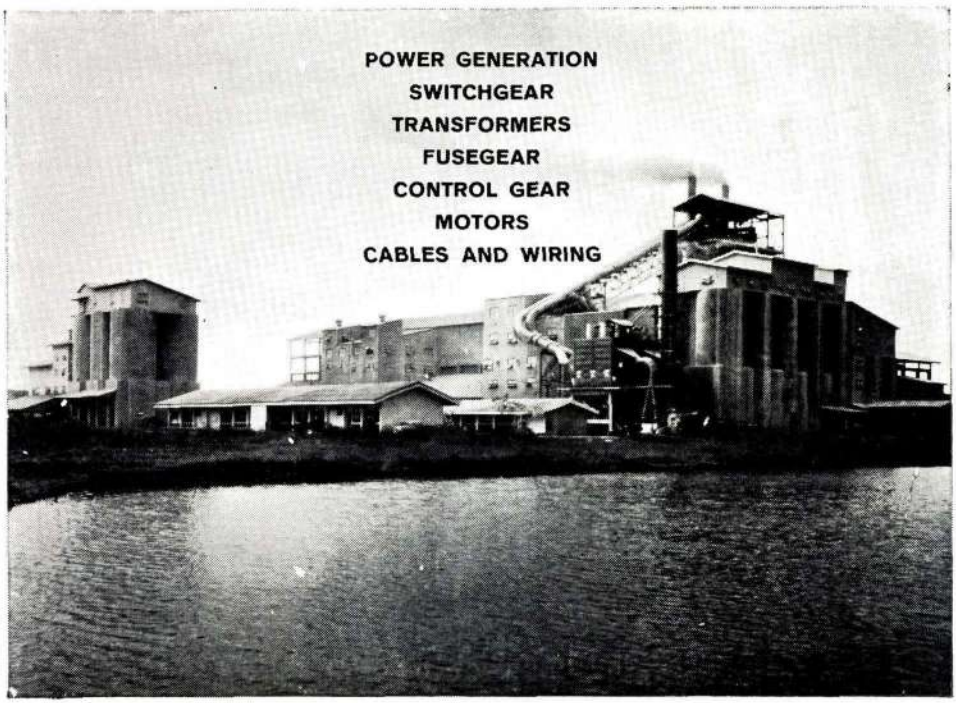


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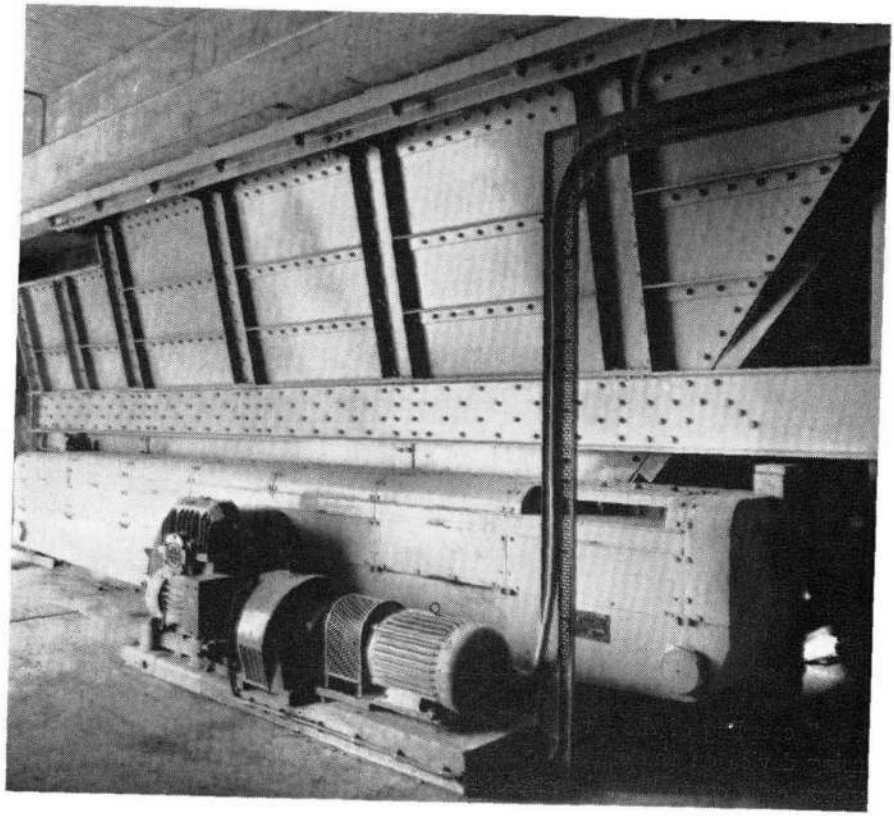

**Fig. 4.—Grizzly Feeder at Southam Works.**

Portland Cement Co., Ltd., a compact crushing plant has been developed by G.E.C. (Engineering) Ltd. The plant is to be installed at the works at Southam, Warwickshire, where an extensive modernisation scheme is in progress.

The plant (*Fig.* 3), which comprises of jar-bar grizzly feeder supplying a Dyad double-rotor hammermill, has a capacity of 300 tons per hour and is capable of receiving 42-in. run-of-the-quarry limestone and reducing it to 1½ in. in one pass, thus eliminating the need for a secondary crusher. By using a jar-bar grizzly, the fines and graded stone are scalped out from the feed thus relieving the load on the hammermill. The jar-bar grizzly (*Fig.* 4) is mounted immediately below the hopper where it receives directly the full impact of 15-ton truck-loads of the run-of-quarry stone and then feeds the oversize material to the crusher.

The jar-bar grizzly feeder is 6 ft. wide and 25 ft. long. It has twenty-one elliptical rolls (*Fig.* 5) and weighs 39 tons. If necessary, the spacing between the rolls at any or all points along the machine can easily be changed, in multiples of 1 in., from the basic setting of 1½ in. The machine is driven by 35-h.p. 1,440-r.p.m. squirrel-cage motor direct coupled to a Heenan & Froude "Ajusto-

**Fig. 5. Grizzly Feeder at Southam Works.**

spede " coupling of the air-cooled stationary-field eddy-current type. A load-sensing device on the crusher controls the speed of the grizzly drive thereby automatically controlling the rate of feed and preventing the crusher from being overloaded.

The crusher is a Dyad double-rotor hammermill weighing 61 tons. The diameter over the tips of the swing hammers and the width of the feed opening are 70 in. The feed enters the crusher on the centre-line, and large pieces can rest on the disks while the hammers break them down and drive them past the heavy anvil and through the cages below. Any wear of the hammer can be compensated for by raising the adjustable cages towards the hammer circles. The end-casings of the crusher are removable in one piece to allow full access to the rotors. The suspension bars, upon which the hammers are swung, can be removed sideways through openings on the flywheels. The crusher rolls are driven, through vee belts, at about 380 r.p.m. by means of two 3·3-kV. 300-h.p. 980-r.p.m. squirrel-cage motors. The reduction ratio achieved in a double-rotor hammermill is high. The installation shows how simple a primary crushing installation can be. The advantages claimed for this type of plant include less civil engineering work, less weight than an equivalent gyratory machine, and consequently a service crane of less capacity is needed. The use of the jar-bar feeder saves space because it does the combined duty of an apron feeder and a heavy grizzly.

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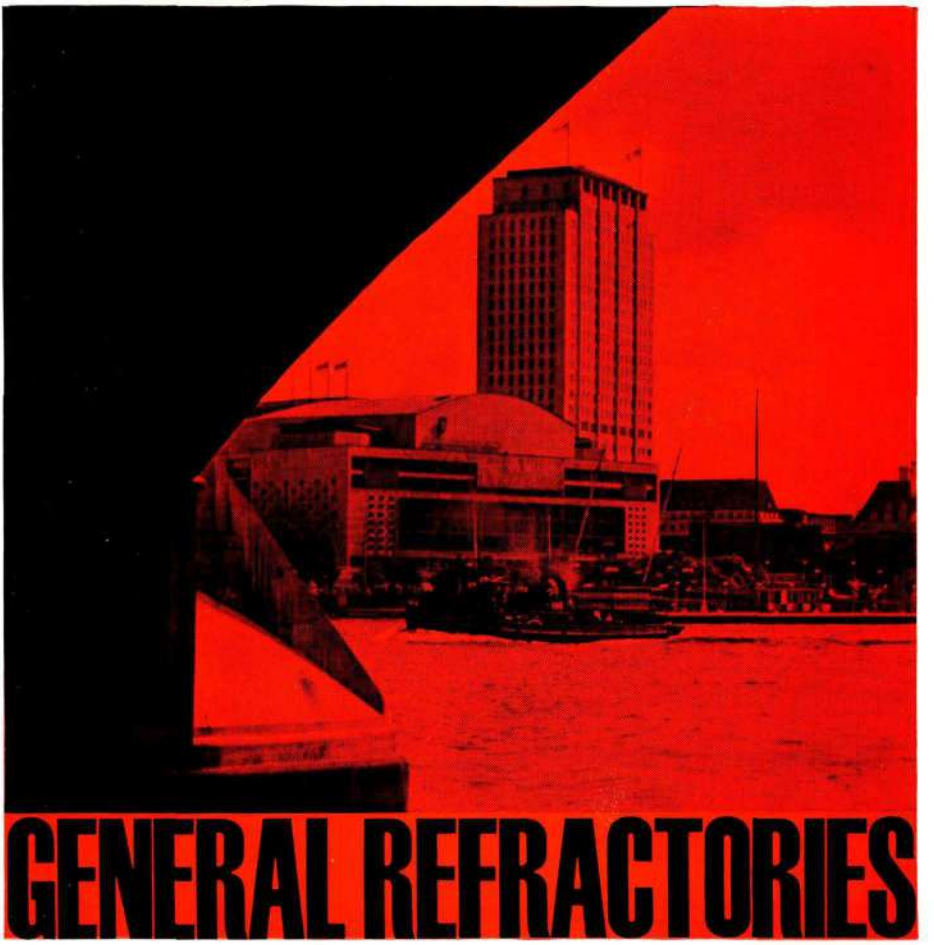

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